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UTILITY
PATENT APPLICATION
TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	476-1827
First Inventor or Application Identifier	King
Title	Reduced Data Rate Communication System
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Washington, DC 20231

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

1. [X] * Fee Transmittal Form (e.g., PTO/SB/17)
   (Submit an original and a duplicate for fee processing)

2. [X] Specification   [Total Pages   14   ]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure

3. [X] Drawing(s) (35 U.S.C. 113)   [Total Sheets   3]

4. Oath or Declaration   [Total Pages   3]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R. § 1.63(d))
      (for continuation/divisional with Box 16 completed)
      i. [ ] DELETION OF INVENTOR(S)
         Signed statement attached deleting
         inventor(s) named in the prior application,
         see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

*NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY
FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT
IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).*

5. [ ] Microfiche Computer Program (Appendix)

6. Nucleotide and/or Amino Acid Sequence Submission
   (if applicable, all necessary)
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [X] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement   [ ] Power of
       (when there is an assignee)   [ ] Attorney
9. [ ] English Translation Document (if applicable)
10. [ ] Information Disclosure   [ ] Copies of IDS
        Statement (IDS)/PTO-1449   [ ] Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503)
        (Should be specifically itemized)
13. [ ] * Small Entity   [ ] Statement filed in prior application,
        Statement(s)   [ ] Status still proper and desired
        (PTO/SB/09-12)
14. [ ] Certified Copy of Priority Document(s)
        (if foreign priority is claimed)
15. [ ] Other: ....
        ....

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment.
    [ ] Continuation   [ ] Divisional   [ ] Continuation-in-part (CIP)   of prior application No: _____/_____
    Prior application information: Examiner_____   Group / Art Unit:_____
    For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied
    under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by
    reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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REDUCED DATA RATE COMMUNICATION SYSTEM

FIELD OF THE INVENTION

This invention relates to a reduced data rate communication
system, to a method of controlling such a system, and to
5   apparatus for use in such a system.

BACKGROUND TO THE INVENTION

In a typical fixed wireless access system each subscriber is
provided with a subscriber transceiver system which is located at
the subscriber's premises and which is in radio communication
10   with a radio base station which it shares with other subscribers in
the locality. In the Nortel Fixed Wireless Access (FWA) system,
the transmit and receive bands between the subscriber transceiver
systems and the base station are in the 3.5GHz region. Typically
the system may utilise one or more base stations arranged on a
15   cellular frequency re-use planning basis, and the base stations may
be connected to the local exchange by a standard 2Mbit/s G703
link using the V5.2 or other concentrating interface standards.
However it will be appreciated that other systems may be used,
for example channel-associated signalling (CAS) systems.
20   The number of subscribers per base station can range from
typically up to 75 in a sparsely populated rural area to around
3000 in a densely populated urban area, depending on how many
transceivers are provided at the base station. In a typical tri-sector
arrangement, each sector is capable of providing sixty voice calls
25   or thirty data calls. The voice calls may be coded using a 32kbit/s
ADPCM (Adaptive Differential Pulse Code Modulation) coding
scheme, whereas the data may be coded using a 64 kbit/s PCM A-
Law or μ-law coding scheme. This is found to give excellent voice
quality and data transfer at very acceptable rates.

However, with the phenomenal increase in the use of data services and internet applications such as web browsing, the typical usage of the line by the subscriber has changed enormously. Originally telephone lines and communications links with local exchanges
5   (central offices) were primarily designed to handle voice traffic of relatively short holding times typically of an average of about three minutes. An internet call consists of data traffic and a typical holding time can be about thirty minutes or considerably longer. This can create a problem in fixed wireless access systems and
10 indeed other more conventional telephone networks, both because of the extended length of these calls and due to the fact that they can effectively occupy two potential voice lines, and so there is a real likelihood of blocking at peak times. Also, many Internet service providers have a point of presence at the local exchange
15 and so these extended calls are charged at local rate only.

OBJECT OF THE INVENTION

The invention seeks to provide a system which can service a reasonable number of subscribers making voice and data calls and which distributes the channel capacity to reduce the possibility of
20 blocking.

SUMMARY OF THE INVENTION

Accordingly, in one aspect, this invention provides a communication system comprising a plurality of user stations each capable of communicating via a respective user channel with a
25 base station having a limited data traffic capacity, each user channel having associated therewith coding means operable for encoding data at a plurality of different pre-set data rates, said system further including monitoring means for monitoring the amount of data traffic at said base station and for causing one or
30 more of said coding means to operate at a reduced data rate if the

amount of data traffic at said base station exceeds a predetermined level, thereby to increase the number of user channels available.

Preferably, said monitoring means is operable to cause said coding means to operate at the same data rates in the uplink and downlink directions.

Preferably said coding means at said user station and the corresponding coding means at said base station are each capable of operating at a plurality of different data rates, and said monitoring means is operable to switch both of said coding means to a particular coding data rate.

The system preferably includes respective coding means for the uplink and downlink directions, and said monitoring means is preferably operable to control the coding data rates in both the uplink and downlink directions.

The monitoring means may be operable to control the coding means to apply different coding data rates in the uplink and downlink directions.

Where the modems at each end are capable of re-training during a call, said monitoring means is preferably operable to cause said coding means to change the coding data rate during a call if the data transfer at said base station exceeds a predetermined level.

In another aspect, this invention provides a fixed wireless access system comprising a plurality of user stations capable of communicating via respective user radio channels with a base station having a limited data traffic capacity, coding means operable for encoding data at a plurality of different pre-set data rates, said system further including monitoring means for

monitoring the amount of data traffic at said base station and for
causing said coding means to reduce the data rate if the amount
of data traffic at said base station exceeds a predetermined level,
thereby to increase the number of user channels available.

5   In yet another aspect, this invention provides a method of
controlling a communication system comprising a plurality of user
stations capable of communicating via respective channels with a
base station having a limited data traffic capacity, each user
channel having associated therewith coding means operable for
10   encoding data at a plurality of different coding rates, which
method comprises monitoring the amount of data traffic at said
base station and reducing the data coding rate if the amount of
data traffic at said base station exceeds a predetermined level,
thereby to increase the number of user channels available.

15   The coding rates in the uplink and downlink directions may be the
same or different.

Whilst the invention has been described above, it extends to any
inventive combination or sub-combination of the features set out
above or in the following description.

20   **BRIEF DESCRIPTION OF THE DRAWINGS**

The invention may be performed in various ways, and an
embodiment thereof will now be described, by way of example
only, reference being made to the accompanying drawings, in
which:-

25   Figure 1 is a schematic diagram of a fixed wireless access
telephone system incorporating a reduced data rate in accordance
with this invention;
          Figure 2 is a more detailed schematic diagram of the system

of Figure 1 showing data transfer from a subscriber's modem, via the fixed wireless access system and the PSTN switch to the modem of an internet service provider;

Figure 3 is a flow chart illustrating operation of the capacity
5   management module incorporated in the embodiments of Figures 1 and 2 to select the data rate for a new data call in accordance with channel availability, and

Figure 4 is a flow chart illustrating operation of the capacity management module incorporated in the embodiment of Figures 1
10   and 2 to adjust the data rate of existing data calls in progress to increase channel availability.

Referring initially to Figure 1, the illustrated embodiment of fixed wireless access system comprises a plurality of residential service systems 10 installed at respective subscriber premises. The
15   residential service systems 10 incorporate a subscriber line interface card 12 and a residential transceiver unit 14. The residential transceiver unit 14 may be externally mounted and includes an integral antenna 16 in a near line of sight with an integrated base station 18. The external antenna 16 is preferably
20   directional and aligned towards the integrated base station 18. The integrated base station 18 comprises a mast 20, a unidirectional antenna arrangement 22, and a transceiver microwave unit 24.

The subscriber line interface card 12 provides the subscriber with
25   two analogue telephone lines 26 and incorporates a linear codec (see Figure 2). Standard subscriber equipment may be connected to the subscriber line interface card 12, such as for example a voice handset 28, a modem 30, a fax machine (not shown). The base station 18 transmits and receives data across respective radio
30   links with a plurality of residential service systems 10 in the locality it serves, and is connected to the local exchange 32 by a backhaul such as a land line 34 or a microwave link. Internet

service providers (ISPs) 36 may have a point of presence at the local exchange or they may be accessed via the PSTN or other network 38.

In this particular implementation, for voice, the CCITT G721
5   32kbit/s ADPCM (Adaptive Differential Pulse Code Modulation) coding standard is used to provide high quality speech. When data tones are detected in the voice band, the coding scheme is changed automatically to provide a 64kbit/s PCM coded channel, thereby making the system fully transparent to all PSTN voiceband
10   data modems.

Referring now to the more detailed schematic diagram shown in Figure 2, in this embodiment of fixed wireless access system, a subscriber connects his computer 40 to the residential service system 10 via a modem 30 and an analogue line 42.   The
15   residential service system 10 converts the analogue signal from the modem 30 into a digital signal which is then modulated onto a carrier by the residential transceiver unit 14 and transmitted across the air interface 44 to the base station 18. The residential transceiver unit 14 includes a capacity management module 58
20   which includes modem detect circuitry and determines an appropriate PCM coding scheme (as to be described below), applies this and also notifies the base station 18 of the PCM coding scheme adopted, so that the codec functions at the residential transceiver unit 14 and at the base station 18 are
25   switched as a pair, in both the uplink and downlink directions. One method of distinguishing a modem call from a voice call is to detect the initial data tone, e.g. the 2.1KHz tone (ANS) or (ANSam) tone.   The coding scheme adopted by the residential transceiver unit and the base station is configured to provide the
30   appropriate PCM coding. The base station 18 processes the signal for onward transmission to the local exchange 32, along a PCM 30 backhaul 34. The signal is transmitted via the local exchange 32

to the other party which here is shown as a modem 35 in the the modem pool of an Internet Service Provider (ISP) 36 which here is assumed to have digital access to the local exchange 32, although as shown in Figure 1, the ISP 36 may instead be located away
5 from the local exchange and connected thereto by the PSTN 38. The other party could also be another home subscriber with a modem connected digitally, apart from the final analogue loop.

Both the subscriber modem 30 and the server modem 35 incorporate processors to effect the necessary protocols,
10 modulation and demodulation of the signals and to probe the line from time to time to establish the maximum available data transfer rate. Each modem also includes a digital pad attenuator for inserting attenuation as required into the call to adjust the level of the call as appropriate for the quality of the link.

15 Referring now in more detail to the data flow in the above arrangement, data from the PC 40 passes in digital format to the modem 30 typically along an RS232 connection. The modem then converts the digital data signals into corresponding analogue signals for transmission over the analogue telephone line. The
20 analogue telephone signal is passed to the subscriber line interface card 12 of the residential service system 10. At the subscriber interface 12 the uplink signal passes via a hybrid 48 to an analogue to digital converter 50 and thence to a linear codec 52 where it is coded and passed to the residential transceiver unit 14
25 at 64kbit/s. At the residential transceiver unit it is modulated by a codec 54 according to a coding scheme to be described below and then transmitted across the air interface 44 to the base transmitter station 18. At the base transmitter station 18 the signal is supplied to a codec 56 providing a variety of coding
30 schemes equivalent to those at the residential transceiver unit 14. For example, as shown, the residential transceiver unit 14 and the base station 18 may be capable of providing coding schemes such

as a null scheme 64 kbit/s PCM (data type) 32 kbit/s PCM (data type) 32 kbit/s (voice type) 16 kbit/s PCM (data type) 8 kbit/s PCM (data type) etc. In the uplink path, the codecs 54, 56 in the residential transceiver unit 14 and at the base station 18 are switched as a pair under the control of the capacity management module 58 which monitors the data bandwidth available and/or the numbers of free channels available and, for data calls, implements a reduced rate coding scheme on data calls if the number of free channels available falls below a pre-set threshold. Thus, provided there is plenty of capacity available, the residential transceiver unit and the base station codecs 54, 56 will be switched by the capacity management module to provide 64kbit/s data rate (null coding). However, as the number of subscriber channels in use at any one time increases to above the preset threshold, the capacity management module 58 implements a progressively reduced rate coding scheme such as 32 kbit/s, 16 kbit/s, 8 kbit/s (voice/data type) depending on the capacity available.

From the base station 18, the coded signal passes via a linear codec 60 and is transmitted via a standard link (e.g. PCM 30) to the local exchange 22 and thence via a digital line such as an E1 line 62 to the modem 35 in the modem pool of the ISP 36.

The downlink data route is similar, but recent standards have allowed asymmetric data rates in the uplink and downlink directions, achieving this by direct control of the PCM data lines at the exchange. In addition, it has recently become possible to increase the data rate in the downlink direction by schemes such as K56 flex, X2 and others. It will of course be appreciated that the flexible data rate scheme described here may be used in conjunction with these recent improvements. In the downlink route, the data passes from the ISP modem via the E1 line 62 to the local exchange 32 and via a standard link 64 to the base station 18.

At the base station 18, the signal is modulated by a linear codec 65 and then, as with the uplink direction, one of a number of predetermined coding schemes is implemented by the base station downlink codec 66. The signal is then transmitted across the air
5   interface 44 to the residential transceiver unit 14 which includes a downlink codec 68 which again is switched as a pair with the base station downlink codec 66 to provide appropriate coding such as 64kbit/s data, 32 kbit/s voice, 32 kbit/s data, 16 kbit/s data, 8 kbit/s data etc. As before the codecs 66 and 68 are switched as
10 a pair by the capcity management module 58. From the residential transceiver unit 14, the signal then passes through the subscriber interface card 12 via the modem 20 to the subscriber's PC 40.

Referring now to the flow charts in Figure 3 and 4, the capacity management module will be described in more detail. At 70, the
15 incoming calls are monitored or "sniffed" to detect a data call. When a data call is detected the monitor determines at 72 whether the base station has the bandwidth available to allocate another 32kbit/s channel. If there is sufficient bandwidth available then a second channel is allocated at 74, whereupon the capacity
20 management module prepares to change the type and rate of modulation and thereafter at 76 initiates the change at both the base station and residential base unit codecs 54, 56 so that the highest data rate of 64kbit/s PCM is selected. The module thereafter continues to monitor capacity and provided there is still
25 sufficient capacity no action is taken.

However, if on detection of a data call, there is insufficient bandwidth available (or if it is determined at 78 that there is no longer sufficient capacity of an existing data call) the capacity management module 58 determines and selects at 80 the highest
30 data rate permissible given the current call capacity and prepares to change the codec type and signals this to the residential transceiver unit 14. The change is then implemented so that the

data arrives in a sub-64kbit/s data channel.

It should be noted that it would also be possible to implement this system without providing the facility of changing the data rate during a data call. Indeed, change of data rate during the call
5   should only be implemented in systems in which the modems are capable of re-training during a call.

Referring now to Figure 4, in this arrangement the capacity management module is capable of tearing down a call in progress when it determines that the system is blocked (or is likely to).
10   Again, this feature will normally require that the modems are capable of retraining.

The management module 58 monitors bandwidth availability at 82 and if there is adequate bandwidth no action is taken. If however there is insufficient bandwidth, the capacity management module
15   prepares to change the codec type at 86 and at 88 signals its intention to the residential transceiver unit 14. It then makes the change at 90 and determines at 82 whether there is now sufficient capacity. If there is still insufficient capacity, the capacity management module selects another modem call at 84 and
20   performs the same routine and repeats this until there is sufficient capacity.

In the above arrangement the capacity management module 58 effectively monitors the number of calls or the channel capacity available and if the number of calls exceeds a pre-set threshold (or
25   the capacity falls below a preset threshold) it selects the best codec function in accordance with the available capacity. As required the data rate is reduced so that, for example, instead of applying 64kbit/s PCM (8bits x 8KHz) it applies a lower data rate, e.g. 32kbit/s PCM (4bits x 32kbit/s) so that another 32kbit/s
30   channel is freed. When the coding rate is reduced, the data width

decreases accordingly and so not all of the 255/256 quantisation levels are required. In addition, the ISP modem 35 and the subscriber modem 30 need to determine which of the quantisation levels are in use at the lower data rates. Thus at 32kbit/s the data width is 4bit and so only 16 of the standard 256 levels by the PSTN are employed. For this purpose when the data rate is changed, the modems 30, 35 train or re-train to maintain the optimum data rate available. The modems then implement via the digital attenuation pads an appropriate mapping which takes account of the reduced number of quantisation levels required and selects those corresponding to the A-Law or µ-Law coding as required by the network.

Various alternative coding schemes are also possible; for example if the data rate is to drop from 64kbit/s PCM to 32kbit/s PCM, the information may be conveyed in the four most significant bits, with the four least significant bits not being transmitted.

At the same time as arranging for the reduced data rates, the capacity management module 58 will also reallocate calls to the freed slots to maximise the traffic carried by the base station.

It should also be appreciated that the system could operate on demand, with data yielding to voice calls.

As well as providing reduced data rate to avoid blocking, the system may also be adapted to provide tiered service levels with significantly increased or guaranteed higher data rates for premium customers and/or progressively slower data rates for standard rate subscribers customers and subscribers who are late in paying their bills.

CLAIMS

1.   A communication system comprising a plurality of user stations capable of communicating via respective user channels with a base station having a limited data traffic capacity, coding

5   means operable for encoding data at a plurality of different pre-set data rates, and monitoring means for monitoring the amount of data traffic at said base station and for causing said coding means to reduce the data rate if the amount of data traffic at said base station exceeds a predetermined level, thereby to increase the

10   number of user channels available.

2.   A communication system according to Claim 1, wherein said monitoring means is operable to cause said coding means to operate at the same data rates in the uplink and downlink directions.

15   3.   A communication according to Claim 1, including coding means at said user station and corresponding coding means at said base station each capable of operating at a plurality of different data rates, wherein said monitoring means is operable to switch both of said coding means to a particular coding data rate.

20   4.   A communication system according to Claim 1, including respective coding means for the uplink and downlink directions, wherein said monitoring means is operable to control the coding data rates in both the uplink and downlink directions.

5.   A communication system according to Claim 4, wherein said
25   monitoring means is operable to control the coding means to apply different coding data rates in the uplink and downlink directions.

6.   A communication system according to Claim 1, wherein said monitoring means is operable to cause said coding means to

change the coding data rate during a call if the data transfer at said base station exceeds a predetermined level.

7.   A fixed wireless access system comprising a plurality of user stations capable of communicating via respective user radio channels with a base station having a limited data traffic capacity, coding means operable for encoding data at a plurality of different pre-set data rates, said system further including monitoring means for monitoring the amount of data traffic at said base station and for causing said coding means to reduce the data rate if the amount of data traffic at said base station exceeds a predetermined level, thereby to increase the number of user channels available.

8.   A method of controlling a communication system comprising a plurality of user stations capable of communicating via respective channels with a base station having a limited data traffic capacity, each user channel having associated therewith coding means operable for encoding data at a plurality of different coding rates, which method comprises monitoring the amount of data traffic at said base station and reducing the data coding rate if the amount of data traffic at said base station exceeds a predetermined level, thereby to increase the number of user channels available.

9.   A method according to Claim 8, wherein the coding rates in the uplink and downlink directions are the same.

10.   A method according to Claim 7, wherein the coding rates in the uplink and downlink directions are different.

Abstract of the Disclosure

REDUCED DATA RATE COMMUNICATION SYSTEM

A reduced data rate communication system, such as for example a fixed wireless access system, comprises a plurality of user stations each capable of communicating with a common base station.

The user stations can make voice or data calls. The data rate available during a data call is controlled in accordance with the bandwidth or channel capacity available so as to reduce the possibility of blocking whilst still allowing access to the required number of users. The data rate may be reduced prior to or during the data call.
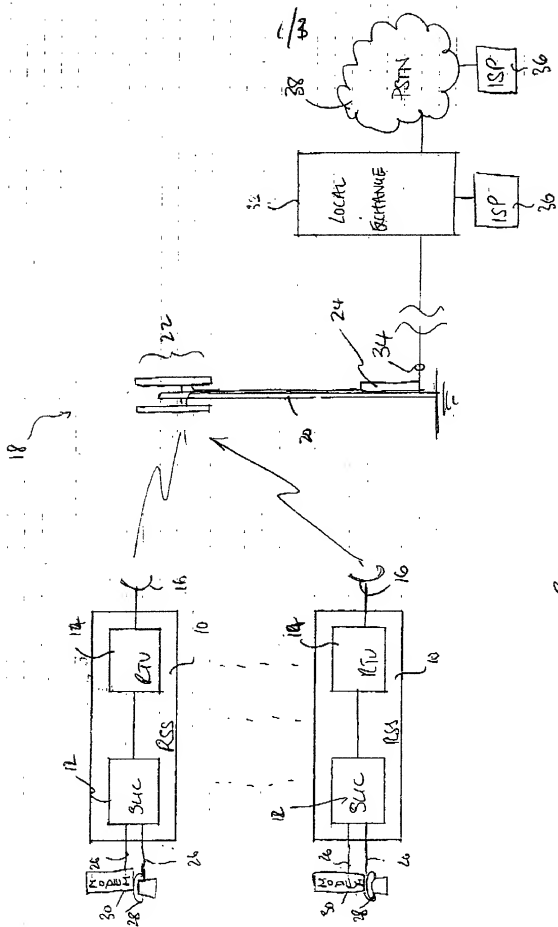
1/3

Fig 1

213

ISP

36

62

32

C O L A L E X C H A N G E

22

CODER 6

CODE 65

CAPACITY MONITOR

18

58

54

14

44

66

68

NULL BLOCK | 32K DATA | 32K NOISE | 16K DATA | 8K DATA

SOFTWARE IMAGE HEIST MODULE

CODEC

A→D

D→A
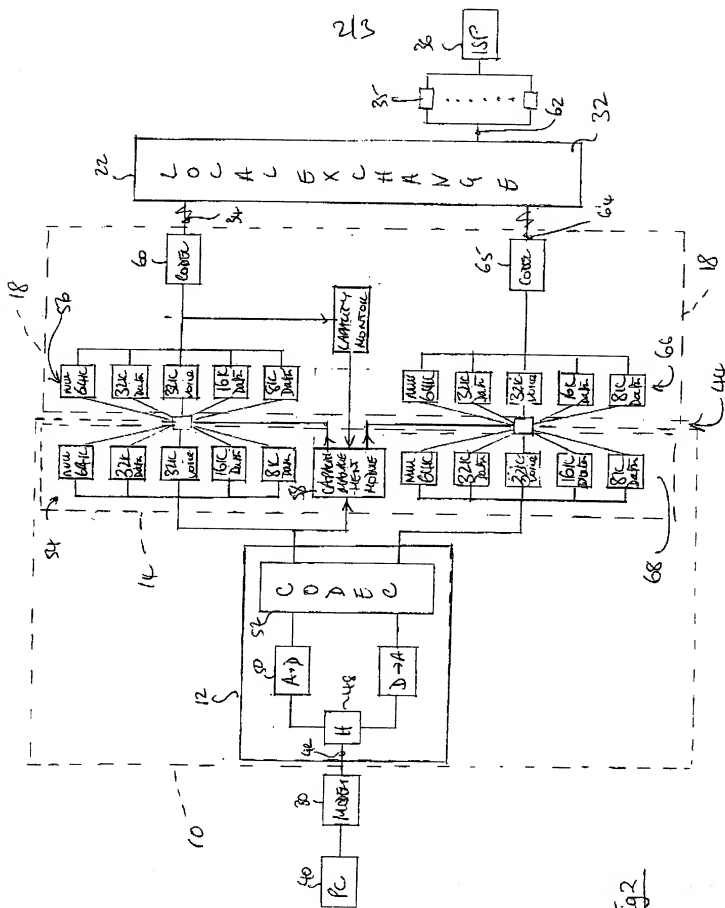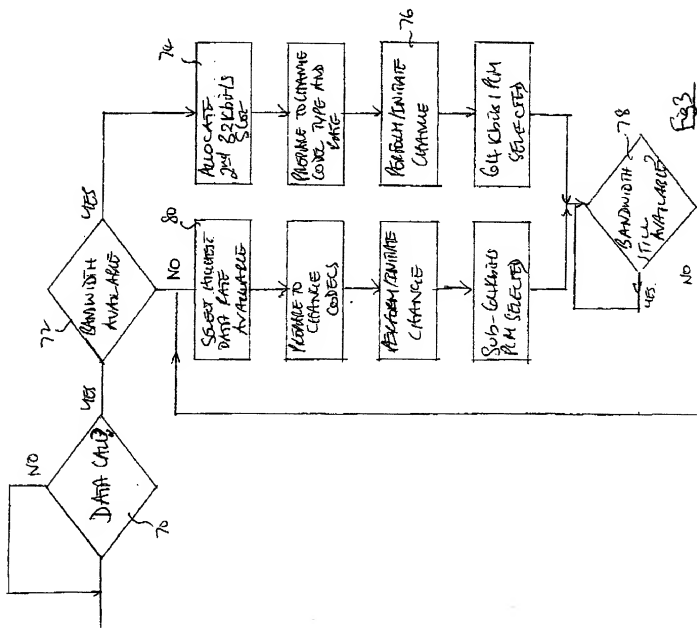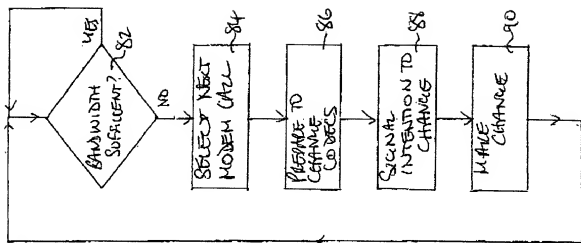
H 48

52

MODEM 30

PC 40

12

10

Fig 2

Fig. 4

Fig. 3

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **Reduced Data Rate Communication System**, the specification of which:

☒   is attached hereto.

☐   was filed on _____ as

       Application Serial No. _____

       and was amended on _____ if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Section

119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

			Priority Claimed	
Country	Number	Date Filed	Yes	No
_____	_____	_____	☐	☐
_____	_____	_____	☐	☐

I hereby claim the benefit under Title 35, United States Code Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

Application Serial No.	Filing Date	Status
_____	_____	_____
_____	_____	_____

And I hereby appoint Wm. Marshall Lee, Registration No. 16,853, John M. Mann, Registration No. 17,775, Thomas E. Smith, Registration No. 18,243, Dennis M. McWilliams, Registration No. 25,195, James R. Sweeney, Registration No. 18,721, William M. Lee, Jr., Registration No. 26,935, Glenn W. Ohlson, Registration No.

ID0769:N J R King

No. 19,286, Gerald S. Geren, Registration No. 24,528 and Peter J. Shakula, Registration No. 40,808 as my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith. It is requested that all communications be directed to Lee, Mann, Smith, McWilliams, Sweeney & Ohlson, P.O. Box 2786, Chicago, Illinois 60690-2786, telephone number (312) 368-1300.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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